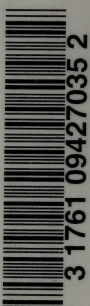
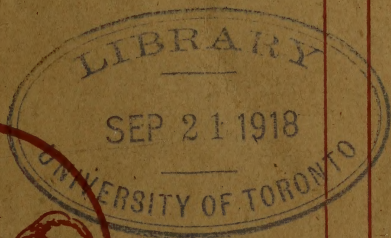


L. J. ARRIGON

III

INDUSTRIAL FRANCE
= AND THE WAR =

SAINT-ETIENNE
AND LYONS



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SAINT-ETIENNE
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ROUND ABOUT

SAINT-ÉTIENNE

Since the war began, many are the French towns and provinces that afford marvellous visions of activity and fruitful endeavour, bustling, vivid pictures of strenuous life. Yet of all these none can compare with the Saint-Etienne district for the powerful and lasting impressions to be derived from its laborious aspect.

At one time the Loire Department, more particularly the valleys of the Gier, the Furens and the Ondaine, forming to the right and to the left of Saint-Etienne a long belt of industrial agglomerations, was one of the most important metallurgical centres of France. But for a good many years past a gradual decline had set in. Entirely new economic conditions had relegated the district to comparative insignificance. Its former prosperity was eclipsed by the mushroom growth of younger rivals, the smelters, forges, steel and iron works of the Northern and Eastern provinces. These, indeed, were in a privileged situation as regards the supply of raw material, such as coal and iron ore. Whereas the output of the Loire coalfields is small and there is practically no iron to be found in the neighbourhood, the metal works in the North of France were close to the rich coal seams of Flanders and Artois, those in the East had at their disposal a plentiful supply of coke imported from Germany and were

able to draw freely upon the unlimited supply of ore accumulated in the subsoil of Lorraine. In order to adapt itself to the new order of things even a famous firm like the *Forges et Aciéries de Saint-Chamond* established from the first in the valley of the Gier, where it still has its headquarters, had been compelled to create branches in other parts of France, to set up smelters at the mouth of the Adour, within reach of the Spanish ore deposits, and to build large supplementary works in Lorraine and in the North.

To-day the war, as a consequence of the general upheaval resulting therefrom, has reinstated the Loire in its metallurgical pride of place. It was essential, for one thing, to put down plant regardless of expense, to fill the place of that lost to us through the invasion of our Northern and Eastern areas. Again, long before the war, the Loire establishments, unable to compete successfully with Flanders and Lorraine in the making of ordinary steel, had specialised in the production of the very hard steel obtained in the « Martin » furnaces and were provided with the necessary plant. And as there is now a practically unlimited demand for higher-grade steel — the only material used in the manufactures of guns and shells — they suddenly recovered their former supremacy, more unquestioned in fact, than it had ever been before.

My last drive through the Gier valley, in the glowing, stormy twilight of an autumn day has left in my mind a succession of images that will never fade. Under a sky undimmed as yet by the coming storm, with its beautiful pink and pale-green hues gradually merging into a leaden grey, I first caught sight of Givors, hardly recognizable with its brand-new buildings, its countless workshops at every stage of comple-

tion, encroaching ever more upon the adjacent countryside, burying the fair vegetation under a monstrous growth of bricks and ironwork, Givors, overhung by heavy layers of brown and ochreous yellow smoke, an opaque mantel of russet gold, pierced here and there by towering chimneys. A newly-finished blast-furnace crowned at every moment with bursts of flame, cast a lurid, fleeting light over the clouded sky. Anon, I again emerge into the country, a dark-green valley down which the seething river flows headlong, its shallow waters eddying round the sharp stones set in its narrow bed, above which rise tier upon tier of meadows and vineyards, separated checkerwise by banks of earth. Night falls, darkening the green face of the land, while the shadows thicken in the deep hollows.

Couzon looms up in the near distance, a mass of factories, and smoking chimney-stacks. Workshops, cottages built of dark-brown bricks now turned almost black, and assuming in the dim twilight the weird aspect of hoary relics of a by-gone age. The darkness deepens more and more. Electric lights shine forth, picking out the inky background with tiny sparks of fire. As the last glimmer of daylight fades away, the glowing furnaces of innumerable workshops — forges, steel foundries and smelters — burn brighter and brighter, until they are enveloped in a blaze of red and purple glory.

Rive-de-Gier: more factories, more smoke, more flaming chimneys. By this time darkness has claimed all the head of the valley for its own.

Above the Northern uplands, a huge black cloud has risen slowly, its sable drapery making the hills look as if they reached up to heaven and creating an impression of immeasurable height.

From Rive-de-Gier to Saint-Chamond and Saint-

Etienne it is one long succession of busy manufacturing establishments, now straggling and some distance apart, now assembled into solid blocks of toiling activity round some chimney loftier than the rest, as you will see the houses of a tiny village cluster round the sheltering church tower. And still the same predominance of new buildings, many of them unfinished as yet, with their naked girders pointing heavenwards like the leafless trunks of a forest in winter. They stretch away on either side until they are lost in the mysterious depths of the valley. Round the larger factories are long rows of wooden hutments drawn up in straight geometrical patterns, rough shelters after the day's arduous toil for the workmen hailing from every part of the world. Through the panes of the workshop windows, sharply defined shadows are to be seen, moving backwards and forwards round the live braziers. The manifold scenes of the great drama in which fire and molten metal are the leading characters follow one upon the other like moving pictures. The flare of one illuminated hall is followed by another no less dazzling. Myriads of flying sparks blaze forth and die. The darkness is lit up by zigzag flashes, by curling wreaths of flame, by vicious tongues of fire. Not the most elaborate display of fireworks was ever half so entrancing as this endless succession of bright glowing furnaces. And above it all the mighty throb of the big engines rising and falling with mechanical precision.

Every now and again the seemingly endless industrial zone that stretches up to the head of the valley is blotted out as it were by broad gaps of utter darkness. From the depths of these shadows, from the empty spaces where Nature still holds sway, there come sudden puffs of country air, laden with the heavy fragrance exhaled by mother earth before the storm. But

these welcome spells are all too short. Again the dazzling blaze shines forth from the glass walls of spacious workshops.

Beyond Saint-Etienne, in the Furens and Ondaine valleys, at Ricamarie, Chambon-Feugerolles and Firminy, the same sights meet the eye. Saint-Etienne itself, at certain hours of the day, leaves an imperishable impression on the mind. Just before noon, issuing from the National Small-Arm Factory, such a crowd of workmen fill the Rue de Roanne that you might think they were holding a demonstration. Whole battalions of men hurry along the street, lay siege to the tramways and carry them by storm. The population of Saint-Etienne alone has increased by 50.000 workmen during the war. It has been ascertained officially that 65 industrial establishments, which before 1914 gave employment to no more than 51.000 men and 24.000 women, had at the beginning of 1917, 90.000 men and 44.000 women in their employ. In the aggregate, the working population of the Loire Department has increased by more than 200.000 souls. The total amount of the metallurgical productions of the Loire which was only 133 millions francs in 1913 reached 500 millions in 1916.

For the present, the activities of these huge crowds of working men and women are devoted to war work. Steel for guns, projectiles, lorries, tractors, these are what the metal-works of the Gier valley are turning out in vast quantities, day and night. The very glass-works of Givors and Rive-de-Gier have been transformed into steel foundries and shell factories. It is quite a common occurrence, in Saint-Etienne, for a moderate-sized or even a small mechanical workshop to be filled with the loud clanking of shells of every calibre as they are handled and loaded upon trucks. The whole

town, so to speak, has been turned into one large munition factory. I call to mind one of these workshops at the end of the Rue de Roanne, a mere barn in appearance, yet filled to overflowing with 12-inch shells, newly turned out, which were being picked up and moved about like so many glass bottles.

The more important of the Saint-Etienne factories have had to enlarge their premises and to set up numerous branch establishments. The *Société de Construction Mécanique de la Loire*, which used to manufacture bicycles and owned one factory before the war, now owns five. In the original works rifles are being made and in two of the new ones, shells ; a powder-works was built, provided with the necessary plant and set going all within three months. The former industry of bicyclemaking has not been neglected, but has been transferred to an old dye-works.

The *Manufacture Française d'Armes et Cycles*, which before the war employed 2,500 hands in the making of bicycles, sporting guns, revolvers and so forth, is now engaged in turning out fuzes and its daily output equals more than half the production of the spacious works of Messrs Schneider and Co at Harfleur, not to mention field guns, rifles and triggers.

Now this result is due above all to the use of up-to-date plant. Modern machinery does away with the delays and mistakes inseparable from individual hand-work. To quote an instance among many, it used to take an expert to make sure that the barrel of a rifle was perfectly straight. And even so, repeated eye-tests were necessary: speed and quality of production depended mainly upon the skill and experience of the workman. Now, things are entirely different. Ingenious devices have been adopted by the *Manufacture* which reveal automatically whether a gun-barrel is faultlessly

straight or not. If there be the slightest deviation a short circuit is produced, and a small electric bulb is lit up, that points out the flaw. The work can therefore be entrusted to workmen devoid of the long experience and specialised vision that were required of barrel-testers working in the old way. Another device has been adopted, with a slight alteration for the benefit of such workmen as may have lost their eyesight in consequence of a wound received at the front. The short-circuit principle is preserved but instead of lighting a bulb it actuates an electric bell. In this case it is by the sense of hearing not of sight, that the workman perceives the faulty construction of the barrel. Recognising the excellent results achieved by them, the *Manufacture Nationale d'Armes et Cycles* has passed an order for a number of these instruments.

At the present moment the *Manufacture* is extending its premises considerably by the construction of three long workshops, two of which will be five storeys high. These additional workshops are to be provided with hundreds of machine-tools that will increase the output enormously. Nor have the management neglected to bethink themselves of the uses to which this powerful machinery can be put when it is no longer required for munition making. The question has been gone into thoroughly by them and they have decided to turn their attention after the war to the production of sewing-machines and type-writers. The latter industry had hitherto remained undeveloped in France, the country importing largely from England and from the United States, where the best machines were made. There being a great demand for these articles, it is hoped that in the near future France will thus acquire a new source of wealth, and will even be in a position to export a considerable part of her produce.

Saint-Chamond, one of the two greatest metallurgical centres in France and the rival of the powerful Creusot works, is some eight miles distant from Saint-Etienne. Here are the headquarters of the *Compagnie des Forges et Aciéries de la Marine et d'Homécourt*, founded in 1837, and which has its workshops scattered all along the Gier valley, at Assailly, at Lorette and as far as Rive-de-Gier. Like those of the Creusot, the Saint-Chamond works lie in a hollow. They are set in the heart of the hilly district of the Forez with its broadly undulating tree-clad slopes; in the background a tableland that stretches away to the foot of Mont Pilat looms up as a mighty barrier, the vivid colouring of its terraces growing gradually more faint until it is merged at last in the delicate blue of the sky. On this late September afternoon, after one or two heavy showers, a slight mist overhangs the soaking countryside, wrapping it in a silvery haze that blurs its distant contours, while lending here and there a springlike freshness to this autumnal landscape.

Before the war, Saint-Chamond had about 15,000 inhabitants; now the population has more than doubled, the surplus being constituted by the increased personnel of the industrial establishments. At the *Forges et Aciéries de la Marine et d'Homécourt* the number of hands is twice what it was before August 1914. Since the outbreak of hostilities the company have spent some 30 million francs in extending their works, which now comprise over one hundred buildings of every size at Saint-Chamond alone. The daily traffic on their private stretch of railroad averages 200 trucks, each carrying some 10 tons of goods.

As you make your way through the busy work-

shops, almost every step you take reveals some new extension, some increase or modernisation of the plant. Take the steel foundries for instance. Before the war there was but one, now there are two. As soon as you cross the threshold of n° 2 foundry, you receive the peculiar impression caused by factories where the whole of the machinery is of the newest type. There are few workmen about, and those you do see are solely engaged in the task of supervision. You might fancy yourself in an establishment working on half time. Everything is done by machinery ; the very « Martin » furnaces are provided with electrical charging appliances. These extensions and improvements have led to a large increase in the output: since the beginning of hostilities the daily production of steel has risen by 165 0/0 as compared with what it was before the war.

At the foundry the same intensified production is noticeable. In the characteristic dark brown dust that lies upon the ground are aligned rows upon rows of moulds in which big shells of a special pattern, cast in half steel, are cooling off. And such is the heat radiated by their dusky metallic masses that as you leave the hall the outer air strikes cold upon your face, though in point of fact it is a pleasantly warm afternoon. To give an idea of the output now reached it will be sufficient to state that of these heavy shells the foundry turns out daily a number very considerably in excess of twice the figure at which was set down in the early days of the war the usual complement of light shells for each of our « 75 » field guns.

You pass on to the iron works. Here again the plant has become far more powerful than it ever was before. To the huge 6000 ton compressor, to those of 2000 and of 1500 tons, used for forging the tubes of heavy guns, to the many others, less powerful, 4 now ones are being

added of 2000. 1500, 800 and 200 tons respectively, as well as a whole series of different machines required for welding the nozzle-pieces of the heavier shells and weighing from 85 to 350 tons apiece. Nor is it only the number of these engines that is constantly increasing, but also the daily amount of work each of them is made to accomplish. Before the war, the different operations needed for the forging of a heavy gun were spread out over six months; now they are rushed through in six days. Some mills which formerly dealt with 10 tons of material now treat as much as 90 tons.

Every sort of projectile from the light « 75 » to the formidable « 400 », every kind of fuze and these of 10 different patterns, answering the varied requirements of present day artillery fire, some of them real marvels of intricate workmanship made up of some sixty different parts as delicate and minute as those of a chronometer, and necessitating 175 successive operations; every type of gun from the « 75 », Mark Saint-Chamond, to the « 400 », with others of intermediate calibre, the latest models, characterised especially by their long range and rapidity of firing; travelling platforms for the powerful guns mounted on rails ; « tanks », or as to use their official designation in this country « *artillerie d'assaut* », one and all of these are turned out in great numbers at Saint-Chamond.

And the rate of production, too, in such as no one would have dared to contemplate before 1914. From twelve to thirteen times as many fuzes are now made *in one day* as it took a *whole year* to manufacture under pre-war conditions, even when urgent orders were in hand. During the first three years of the war, the Pyrotechnical Department supplied 7500 times as many fuzes as it was able to produce in one year before Au-

gust 1914, when working at high pressure. So with the « 75 » cartridge cases, each of which necessitates as many as 20 operations. From a « *flanc* », or brass disc the size of a large saucer, by successive stampings a sort of cupula is first obtained, to which a deeper, cup-like shape is given next, and finally the long, bright yellow sheath with its thin walls stands completed. The number of these made every day is about equal to three and a half times the total supply provided for each gun in August 1914. As to shells, the production since the outbreak of hostilities runs into quite a respectable number of millions.

And the guns! A mere glance at the spacious artillery hall, containing a sufficient quantity to prepare for an offensive on a big scale at once gives an idea of the output. There are light field pieces, howitzers, and long guns of medium calibre; squat mortars with broad gaping mouths; great shields « camouflaged » in ochre, green and dark brown patches; huge long range guns revolving slowly upon machinery that gives the last polishing touch to their outer or inner tubes; gun-carriages of every type; breech-pieces in process of mounting, the openings of which are as large as the portholes of an ocean-going steamer; *sledges* for the « 155's » weighing 3 tons. Here is a typical case. It is desired, let us suppose, to adapt to land warfare a naval gun of medium calibre, with a range of some 32 miles. It has to be provided with trunnions, a sledge, a carriage on wheels with all its parts, and finally a tractor. Many as are the different operations required, yet it has been rendered possible to turn out one of these guns per day, tractor and all.

A specialty at Saint-Chamond is the manufacture of « tanks », which are made in series in the great artillery hall, where their splinter-proof armour plates

are riveted with a deafening noise and their motors and other intricate parts assembled. Their rate of output is as striking in its way as the production of ordnance.

I had an opportunity of seeing some of the tested on the ground laid out for the purpose at La Perronnière, not very far from Saint-Chamond. There were a number of them here, drawn up in the open, or in sheds and courtyards; others, waiting to be sent to the front, were ready loaded on railway trucks, their heavy, massive bodies, shaped like some strange figure in solid geometry, with long vicious-looking cannon sticking out in front. They reminded one of the fanciful creations of a Jules Verne or a Wells with their prophetic insight into future war conditions. In another shed, three or four of these uncouth monsters were being camouflaged; their steel plates, covered with thick blotches of paint, had all the appearance of a many-coloured Harlequin's coat.

One of them, moreover, proceeded on a trial spin while we looked on. The heavy fass — fore that 20 tons in weight — was set in motion over a track of country soaked with a week's persistent rain, intercepted by deep ruts, here rising in steep knolls, there sinking into the trough of muddy pools. It travelled at a speed of 8 miles an hour, lurching and jolting as it went, imprinting its broad flanges on the soft sticky ground to find a fulcrum for further progress, and leaving behind it a double track such as might have marked the passage of some giant pachyderm of the prehistoric ages. The « tank » successfully negotiated a trench which was at least five feet in breadth, turned to one side — somewhat ungracefully, indeed, but with sure and powerful action went down a slope at an angle of some 30°, wandered into a meadow like some wild beast in quest of its prey, turned round, climbed the slope and

so made its way back to the shed like a well-trained elephant...

And now when I try to picture to myself the effort achieved during the war by that vast metallurgical city built up at Saint-Chamond, my thoughts turn to the little wooden cottage, its walls hung with blue prints and sepia drawings, where sits the general manager of the Pyrotechnical Department, a typical figure of a man whose very soul is in his work, with his powerful thickset frame, his short stubby beard, his shrewd smiling eyes lit up with the fire of a studious, inventive mind, just a slight accent of the Midi betraying his origin, a fluent speaker, passionately attached to his labours. I seem to hear him still as he referred with legitimate pride to the results obtained, astounding me with ever swelling figures, juggling with millions, bewildering me with the description of intricate fuzes, explaining their mechanism, handling the different models arrayed on a shelf above his desk, some bulbous and squat like Byzantine cupolas, some tapering like church towers, as slender as minarets, or terminating in a sort of long spire; taking me round the workshops, where the proportion of women is 90 times what it was before the war, suddenly breaking off in the middle of a sentence to pick up some piece dropped by a careless hand and putting it carefully back in its place.

He reminded me of those early weeks of the war, when the guns were thundering at Charleroi and on the Marne, and it was necessary to speed up production to the uttermost, for stocks ran low and the consumption increased at an alarming rate. He referred to the visits of Government inspectors and to the figures they urged him to reach. At first he had been staggered by their demands. To be asked to achieve such an

output, undreamt of in times of peace, with one's workshops partly disorganised by the mobilisation! But the flame of enthusiasm soon prevailed « We will deliver so many fuzes by such and such a day », he assured one of the generals, confidently mentioning a number slightly in excess of that stipulated by the High Command. It was the general's turn to be dumbfounded « He is talking through his hat! », he observed a few minutes later to one of the directors. But at the appointed date the output held to be practically impossible of achievement was vastly exceeded.

The industrial development of the Loire Department will not be ephemeral. After the hostilities, the activity of the metallurgical and mechanical construction works will be employed for more pacific tasks than at the present time, but will keep all its intensity. In the future, moreover, the Loire metallurgy will be transformed by the electrification of its working processes. More and more, the works use hydro-electric power which is supplied by the Alpine torrents and is distributed at a great distance. The *Aciéries de Firminy* have created an electro-metallurgical workshop for steel production by electric furnaces and ask for another 5.000 H.P. to be supplied to one of its branches, the *Société des Usines de Rioupérourx*. The *Compagnie électrique du Centre et de la Loire* asks for another 5.000 H.P. for Rioupérourx which distributes them to several works of the Loire, including the *Aciéries de la Marine et d'Homécourt*, which are also undertaking electro-metallurgy. Various establishments of the Gier valley receive hydraulic power from the *Société Générale de Force et de Lumière* of which the generating works are situated in Savoie and in the Isère. In short, hydraulic power (houille blanche) will still further increase the powerful vitality of the Saint Etienne region and will make of it one of the most magnificent industrial provinces of France.

WHAT LYONS HAS DONE

==== INDUSTRIALLY ====

==== DURING THE WAR. ====

Lyons, the famous French industrial centre, which seems mostly to be shut up in itself within its somewhat gray and shrouded atmosphere, conveying an impression of coldness — almost of moroseness — Lyons has become almost metamorphosed during the war.

Seeing the city on a beautiful sunny day of September, when it was bathed in a hot, glaring light, barely attenuated by a diaphanous mist, which turned the high yellow barrack-like houses of the Croix-Rousse, as it were, to furnaces, which turned to fire the milky green waters of the Rhône, and rendered the shadows under the delightful shady avenues by the riverside more attractive than ever, I was struck by the extraordinary animation of the streets. It was as if the city had been in the full tide of a festipal.

At noon and at the end of the day's work, from six to seven o'clock, immense crowds besieged the tramways, and they darted about crammed to their utmost capacity. The fronts of all the cafés were crowded with people. On Sunday the Parc de la Tête d'Or was thronged with promenaders; so each evening was the leafy avenue of the Place Bellecour, plunged into semi-obscurity on account of the lighting restrictions.

It was a mixed and kaleidoscopic crowd. Among them were many uniforms, uniforms of African regiments, several of which have their headquarters at Lyons; uniforms of the wounded being treated at the hospitals in the neighbourhood, which are somewhat numerous, since it is a centre of study of the military hygienical service. But the great majority of the crowds was composed of the masses of workers of all kinds who fill the city, engineers and technical workers, working-people of the pre-war period of Lyons and « greater Lyons », specialists temporarily or wholly released from military duties on account of their aptitudes, and many thousands of new-comers, either refugees from the invaded regions or workers from other parts — from the colonies, from the Far East or the North African mountains, who have answered the appeal of the mother-country and hastened to take part in the innumerable industries borne of the war.

Always a city of toil and moil, Lyons has during the war immensely increased and extended her industrial resources. The city's population has indeed almost doubled in this time. Investigations made in January 1917 by the factory inspectors regarding industrial and commercial houses in the Lyons region, showed that if in August 1914, after the mobilisation, the number of these houses fell to 23, 461, on the other hand the rate of increase had never stopped since the beginning of 1915, and in January 1917 it reached 40.070. As to the number of workpeople engaged in these different factories, there were 266.000, as against not more than 238.000 before the war.

There is no branch of industry that has not prospered. The least favoured maintain the place they held before 1914; the others go on progressing and enlarging. The silk industry is, of course, Queen of them all, and

Lyons is, as she ever was, the great exporter to the world of *failles*, of taffetas, of heavy silks, velvets and rich tissues threaded with gold. Freed from German competition, the Lyons silk-industry has made notable extensions in some of its manufactures. That of serges, for example, has increased 30 per cent. New markets have been opened. India has ordered from Lyons silk stuffs woven with gold and silver tissues which were formerly supplied by Germany. Morocco, which only took some 3.968,000 francs worth of Lyons silks in 1913, in 1915 bought for 4.302.000 frs. The United States increased their purchases from 48.769,000 frs in 1913 to 64.740,000 francs in 1915 ; while the purchases of the Argentine were almost trebled, from 3.968,000 francs to 9.543,000 francs. As to Spain, her custom was quintupled, the figures being 1.859,000 francs in 1913, and 9.554,000 in 1915. The total sales abroad in 1916 reached 336.623,000 francs, a sum lower than that of 1913 (429 millions), but higher than that of 1912 (329 millions).

The Lyons tanneries are working at full pressure, and the Oullins establishment, for instance, which has a superficial area of 80.000 square metres, employs 1500 workmen. The factories of macaroni and similar farinaceous produce, which before the war, turned out 15 millions of kilogrammes a year, now produce more than twenty millions. The chemical industries have been renovated, transformed, and doubled in importance. Saint-Fons, at the gate of Lyons, with its long line of brick workshops covering an immense area, is like a huge laboratory from which is turned out an endless procession of acids and salts and all the infinite variety of substances resulting from the chemical art. Another of the three great chemical factories of Lyons finished its working year of 1915 with a profit of 4.926,000 francs against 1.191,625 francs in 1914.

The three Lyons Fairs since 1916 have been a complete success. That of 1916 brought together 1199 French exhibitors and 143 foreign, its turnover being 52 millions ; the Fair of 1917 housed 2169 French exhibitors and 424 foreign, and realised 180 million francs worth of affairs, not counting the 42 millions of business done by catalogue through the United States office. The Fair of 1918, which has just closed, brought together over 3.000 exhibitors, and did business amounting to a figure far in excess of the previous years.

Lyons also naturally has its share of manufacture for the war, and has indeed become a vast arsenal. The State Arsenal at Perrache, where the number of workers has trebled, in view of the impossibility of confining its work to the space assigned to it, has spread over the land and buildings contiguous to the Paris, Lyons and Mediterranean Railway station, and built new barracks reaching to the banks of the Rhône. The staffs employed in powder factories and establishments connected with the making of powder in the Lyons region have increased since August 2nd 1914 by no less than 2440 per cent. Those engaged in privately owned establishments working for the war have increased by 580 per cent. The Hotchkiss Society has workshops at Lyons from whence the machine guns issue by thousands. The great Lyons automobile firms, like Berliet and Rochet-Schneider now have a double rôle. Not only do they carry on the work for which they were built on a much larger scale than before, but like those of Paris, they are also busily engaged in turning out shells.

The Berliet factories, having put in powerful new plant, will be ready as soon as peace is signed to turn out motor cars in series for quick sale with a rapidity

such as before the war was unknown except in the United States. At the Rochet-Schneider establishments I saw the workshops containing the sets of machines for the turning out of shells for the « 75 » guns. In 1914 these workshops did not exist, any-more than did the guns. The whole installation and materiel have been created in these three years of struggle. These workshops are a model of their kind too. Round the machines used for the polishing of the shells there is not an atom of those metallic powders which when they are spread about in the atmosphere render it so noxious for the lungs of the workpeople and are a fatal agent of tuberculosis. The shell turns at a busy rate during the act of polishing, and its surface, softened by the process, takes on lights and reflections like a mirror. But as the steel dust comes off and escapes in light scintillating clouds, an aspirator machine sucks it into its funnel and the silvery powder disappears almost as soon as it is born. When the war comes to an end and there are no more shells to manufacture, all these machines that turn so rapidly and with such miraculous precision will set to work turning out all the varied parts that go to make up a motor-car.

Another consequence of the war is that the factory, while continuing to make cars for the General Staff and wagons of pre-war type, has also created an interesting novelty. For the colonies and protectorates where the roads are still primitive and where motor-cars were wanted for travelling over the worst kinds of ground, such as routes bristling with rocky and stony obstacles, cars « high on their feet » were needed, that is to say, cars provided with wheels of a superior diameter to the normal, which, rising above the frame, would clear all obstacles and render them immune from possible damage therefrom. Up to now the United States had

been alone in the manufacture of this type of car and they had to be brought from overseas. But necessity is the mother of invention, and the importation having become more and more difficult owing to the general scarcity of tonnage, the Rochet-Schneider factory set to work to make these so-called « high on their feet » cars. I have seen some of these vehicles intended for the work of military transports in the Moroccan protectorate, which will negotiate the difficult *bled* without any fear of the consequences.

But the most curious of all the war products of Lyons are the factories that have sprung into being at the behest of the Electrical Lighting Society (*Société « L'Eclairage électrique »*), an enterprise which before the war had five houses either in Paris or its suburbs or in Lorraine, which were given up to the manufacture of electric machines and devices, electric cables, etc. These factories are situated some way out of the city, beyond the fort known as « La Vitriolerie » and the marshy fields to be found in the further reaches of the Rhône, in a suburb whose dusty little gardens have been burned brown by the sun. Here one finds a huge quadrilateral space enclosed in high walls before which sentinels are on guard. Every tramway coming from Lyons along those arid dusty roads brings fresh groups of workmen and workwomen eager to seek employment. On entering one finds an imposing entrance hall lined with wickets disposed in a hemicycle where suspicious guardians are on watch, then a spacious courtyard in front of the façade of the main building in reinforced concrete with high bay windows.

At the declaration of war this huge hall and the other buildings surrounding it and dependent on it, which were intended ultimately for use as slaughter-houses, were temporarily serving the purposes of an

exhibition. The exhibition was forced summarily to close, and all the fragile erections of plaster which then existed have now disappeared. There is but one left, of about 500 metres in length, which flanks the Avenue de Marseille and goes through the factory — a Moorish pavilion with cupolas which has been turned into a mess for the engineers and foremen of the establishment.

When one goes through this factory, which is criss-crossed with railway lines connected with the La Guillotière station, where all over the place are platform-wagons laden with shells of the « 75 » or of higher calibre, varied by heaps of steel bars, of casks and reservoirs of metal, it is difficult to realise the difficulties that had to be overcome in order to transform the buildings as they were, so little adapted to the purpose, into metallurgical workshops. Yet the factory created at Lyons by the « Eclairage électrique » was built and developed with a rapidity such as heretofore had only been dreamt of in connection with American industrial achievements.

On November 26 1914 the Society signed a contract with the State for the supply of shells of the « 75 », and in the early part of December the management of the future factory installed itself in a disused tobacco shop of the old Exhibition, all the buildings being still filled with the objects and belongings of the exhibitors. The removal of the Exhibition and the installation of the factory took place simultaneously. As soon as a space was emptied, a workshop was erected there ; hardly had a building been vacated than the fixing was begun of the masonry foundations on which were to be placed the machines that had already been ordered in America, or to hold the metal supports necessary for the power transmission. For the construction

of these masonry bases the builders followed the descriptions of the machines being built in America which the builders of these latter sent as they were completed by cablegram. On December 8 was commenced the erection of the furnaces for pointing, tempering and annealing the shells. The first machines arrived at the end of 1914 and in the first few days of 1915. They were immediately fastened into their masonry supports which were all ready to receive them. This work was carried on day and night. Forty-eight hours after its arrival, each machine was in working order. The factory issued out of chaos and became organised as one watched it. The various stages were completed with a rapidity that made one giddy ; each day showed marked progress, and in a week's time the place was no longer recognisable.

The steel in bars arrived on January 20th. Without a moment's delay the work of sawing it into pieces was begun. Five days later the electric lighting and motor force installations were in full working order. On February 11th all the furnaces were finished and lighted. On the 22nd the forge was ready. From that date the factory was at work. On February 25th — an historic date — less than three months after the signing of the contract, the first shell was turned out. At the end of March the production was already intensive in this workshop, where there were installed 540 machines and 686 electrical motors.

Since this date the factory has never ceased to make strides in advance. On June 30th 1916 the establishment covered a surface of 88.200 sq. metres, and it had a staff of 9.985 workers. Six months later the superficial area was 100.000 sq. metres and the working personnel was 13.200 persons. 54 per cent of whom were women. As to the number of machines, which was then

2.000, these have by now increased by 50 per cent. It should not be forgotten, moreover, that all the machines used in the manufacture of the ordinary calibre shells were made by the factory itself.

Let us cast a glance at the great hall of the workshop which is devoted to the manufacture of projectiles of small calibre, of the French « 75 », of similar calibres used by the Allies, as well as of that of the medium calibre shell, though the former is by far the most important and occupies three quarters of the immense factory. The infinity of machines, grouped in rectangular sections, each section consisting of several straight lines of them, remind one of a formidable and highly disciplined troop assembled on a field of manoeuvres and formed up with geometrical regularity. But everything the eyes can seize is in motion. The machines go through their complicated exercises with mathematical precision, and with an incessant metallic whirr, under the rhythmic flow of the brownish oil which lubricates the steel wheels or of the lashing white jet of water which serves to lessen the friction. Above all these are wheels and cylinders turning, and all keeping time in the general agitation of the place; great belts zig-zag through the space above one's head, dark slithering bars that seem to be rushing onwards in a frantic race that never ends. One has the sensation of being in a thick wood in which the trees are replaced by a vegetation of metal, which is perpetually shaken by a stormy wind, in which the tempest growls and rages. Small trains of wagons and an electric engine glide easily here and there. Indeed, electricity is the sovereign master here; it works 1100 motors and assures the working of 11.000 metres of line. The implements of manipulation and mechanical transport, driving chains, chain slide bars, driving belts, are working in

every direction, seizing, falling, bending and carrying the shells in all the different stages of their preparation.

The manufacture of a shell requires some forty operations either for its actual fashioning or the different stages of gauging and testing; and each of these forty stages necessitates separate handling and transport. Thus in view of the enormous daily output of the factory in shells of the small calibres, these various stages of the work represent the movement from place to place of some 7.000 tons of steel. Thanks to the development of the transport system, this enormous work is carried out by means of only 704 separate operations. The economy in man power effected by this intensive use of mechanical manipulation may thus be realised. The automatic organisms throughout the factory are spread over a length of 15 kilometres, performing work for which 1200 different manipulations are necessary.

This automatic mechanism is of course paramount in the actual manufacture of the shells. Take, for instance, the work of making the « eye » of the shell — that is to say, the opening in the tip of the « nose » — which requires five operations, including a chasing. The five operations take place without any need of the intervention of the worker who supervises the operation. Each implement is automatically moved in front of the shell, does its work, retires, and the tool-carrier shaft turns a quarter round, the next implement comes forward, and so on.

In the workshops where the « gaine de relai » is made — an accessory which forms part of the fuse — the turns of the implements which are just as automatic are worked four at a time. One of the operations of this fashioning of the « gaines » has allowed of an interesting application of the Taylor system. When carried

out empirically the work resulted in a mean output of only 190 objects per working hour; but after application of the Taylor method, this average output exceeded 362 objects. The great principle of Taylorism is to do away with every movement, every change of place or gesture that has no use. And an unexpected result of the application of the system has been the possibility of making use of mutilated men. In the Lyons factory of the « Eclairage Electrique » one ordinary workman (machine minder) is employed, who has had one arm amputated, while an adjustor is minus both his legs. The box on which this latter takes up his position is hoisted on a stool placed at the same height as the bench.

The use in an ever increasing proportion of mechanical operations and scientific methods of work organisation have resulted in a constant increase in the proportionate output of the factory. By the 1st December 1916, the output of « 75 » shells had increased by 250 per cent in comparison with the figures for August 1915, which were already quite respectable ; that of fuses during the same period had increased by 450 per cent. As to the output of mean calibre shells, these increased between June 30 1916 and December 31 of the same year by 50 per cent.

The example of the « Eclairage Electrique » is taken because it is the most striking of the ten or twenty to be found at Lyons. How much time, how much experimenting would have been necessary some years ago not only to lay the foundations of so important a factory, but for organising and fitting it up! The war, which has caused so much ruin, has had at least the happy result of changing French industrial methods. Not only has it taught this industry to achieve its results quickly, by forcing on it rapidity of conception and of execution

alike, but it has made it necessary to adopt to this end the most modern machinery, and the newest and most venturesome processes. It has furthermore made it face realities and take count of them in defiance of preconceived theories or antiquated usages. It is quite an evolution that has thus been accomplished, which places French industry on a level with that of the countries which up till now had been the best adapted to the conditions which the development of mechanical processes had forced upon the civilisation of our times.

L.-J. ARRIGON.



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